

TPC response simulation

sPHENIX software/simulation meeting

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On behalf of TPC group**



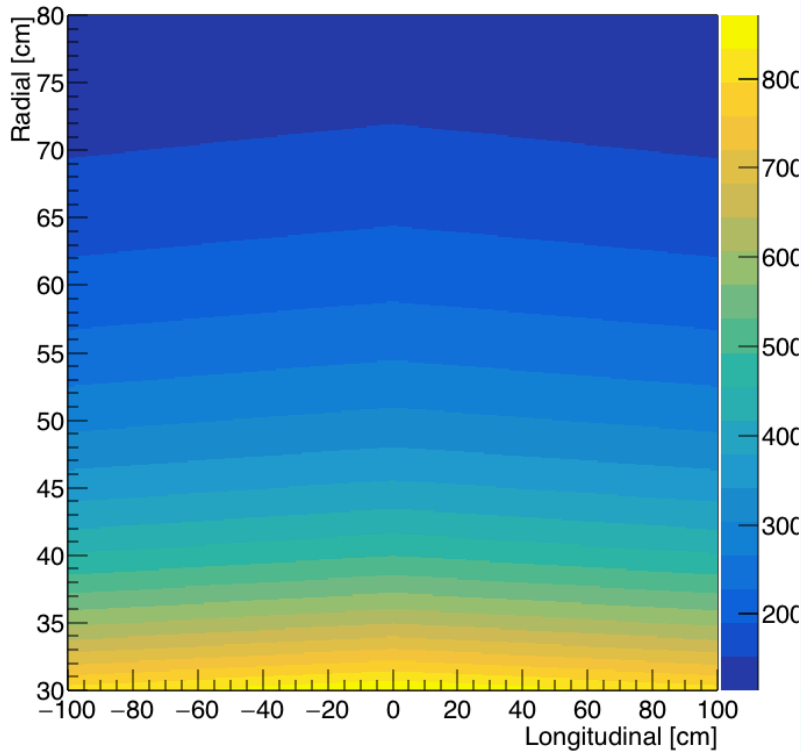
Outline :

- Implementation of distortion in TPC software.
- Charge cloud distortion simulation and signal digitization.
- Implementing Ne2K gas and changing TPC field cage dimension.
- Feasibility of implementing Olympus tracking system in sPHENIX tracking (ref: Talk from Carlos Perez)

Space charge implementation

Currently implemented

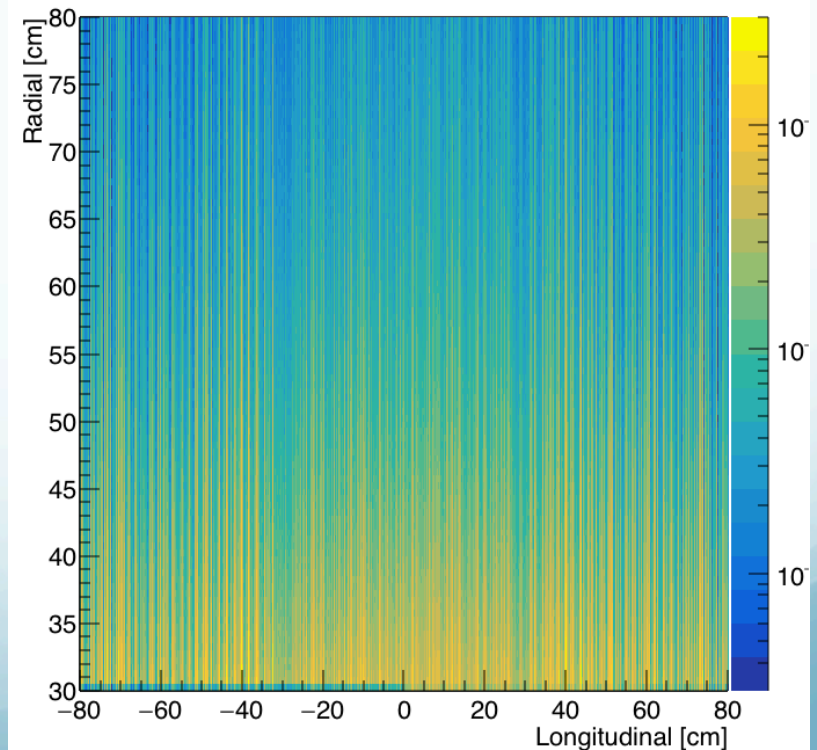
ChargeDensity [fC/cm³]



Future plan

- After discussion with Jin, current approach of applying distortion will undergo change.
 - Instead of altering electron clouds proportional to computed distortion apply the computed distortion from lookup table in addition to random fluctuation.
 - Implement the correction framework to TPC software.
- New lookup table based on output from event Generator
- Inclusion of luminosity and consideration of drift velocity of both electrons and ions.

ChargeDensity [fC/cm³]

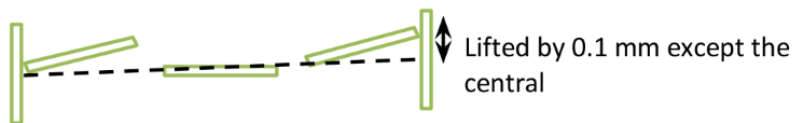


Based on phenomenological formulation

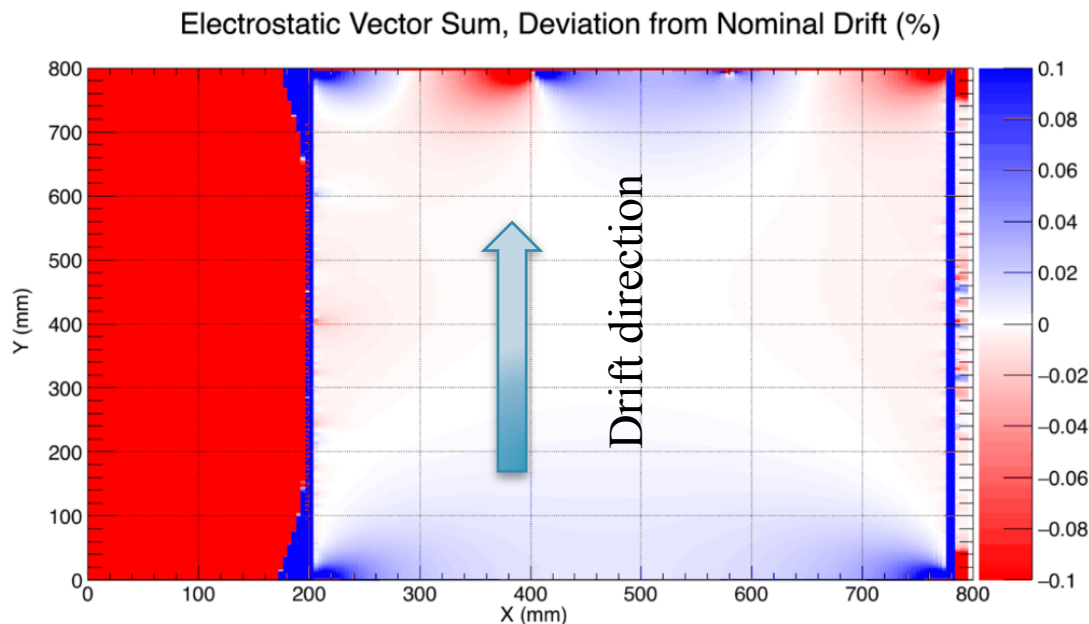
$$\rho(\mathbf{r}_-, z_-) := A \left(\frac{1 - b z + c e}{f_d r^d} \right)$$

- $A = [G] \times [m] \times [r] \times [e_0] / 7668$ [in C/m]
 - $e_0 (= 8.85e-12)$: vacuum permittivity
 - $G (= 1)$: gas factor (prim ioniz./ drift velocity)
 - M : Event multiplicity
 - R : Total interaction rate
- b : 1/Driftlength ; $c \cdot e$ ($c = 1.5$, e : ion back flow ; $d = 1.5$ for ALICE ; $f_d = 1$)

Field cage electric field distortion



- ANSYS calculations show field distortions induced by field cage manufacture errors.



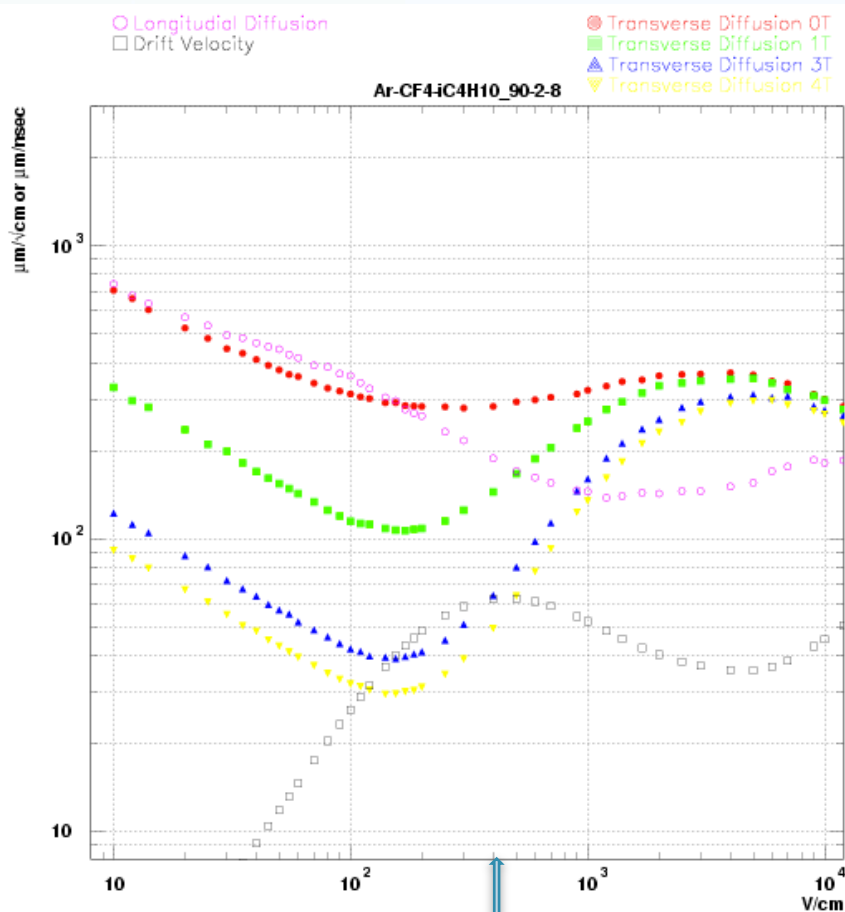
- Coupling these with GARFIELD will produce updated (relaxed) mechanical constraints.

Can be implemented in the software providing us idea of effect of Electric field distortion on electron propagation in addition to diffusion effects.

Charge Cloud distortion simulation and signal digitization

- Readout shaping time and transverse diffusion are important factors for signal shape.
- Current parameters in G4 are very good approximation of expected signal shape from SAMPA+ Ne2K gas.
- More accurate charge cloud distortion simulation is in progress:
 - Results from ANSYS will be used as input for a full propagation of electrons in GARFIELD package.
 - Test with and without inclusion of space charge distortions will be done
 - Simulation of longitudinal profile of charge cloud after GEM amplification and electronics shaping to come as well.

Changes in TPC geometry



400 V/cm (TPC operating voltage)

- Length of TPC field cage :

160 cm \Rightarrow 200 cm

- Radius of TPC :

$R_{\text{in}} = 20/30 \text{ cm} \Rightarrow 24 \text{ cm}$

$R_{\text{out}} = 80 \text{ cm} \Rightarrow 78 \text{ cm}$

- Change in gas : K2K \Rightarrow Ne2K
- Change in pad size.

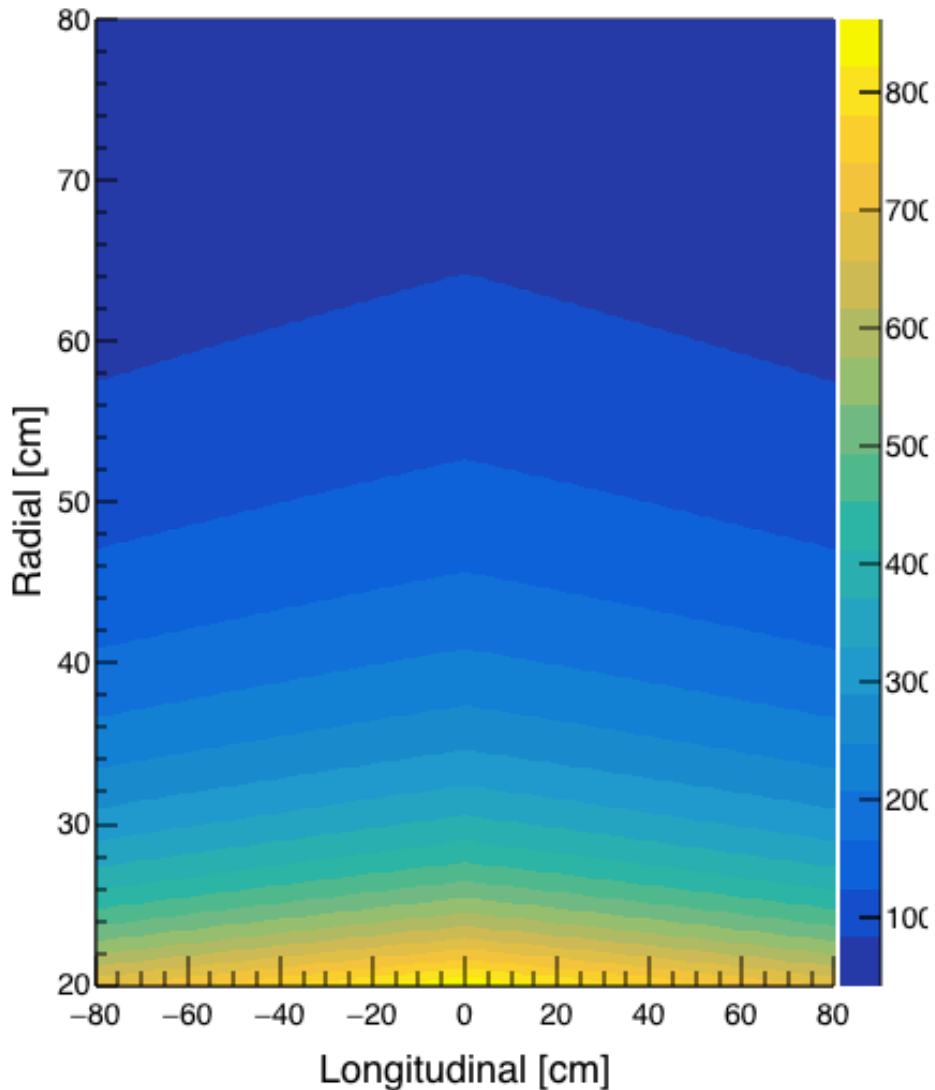
Conclusions :

- Work is in progress on implementing space charge correction framework and preparing final space charge look up table based on more realistic model.
- Important calculation on distortion in TPC field cage electric field due to mechanical imperfection almost finished.
- Simulation on cloud distortion and digitizing signal is in progress.
- Implementation of modified TPC geometry and Ne2K gas parameters in TPC software undergoing.
- Feasibility of using Olympus tracking system for sPHENIX tracking is under study.

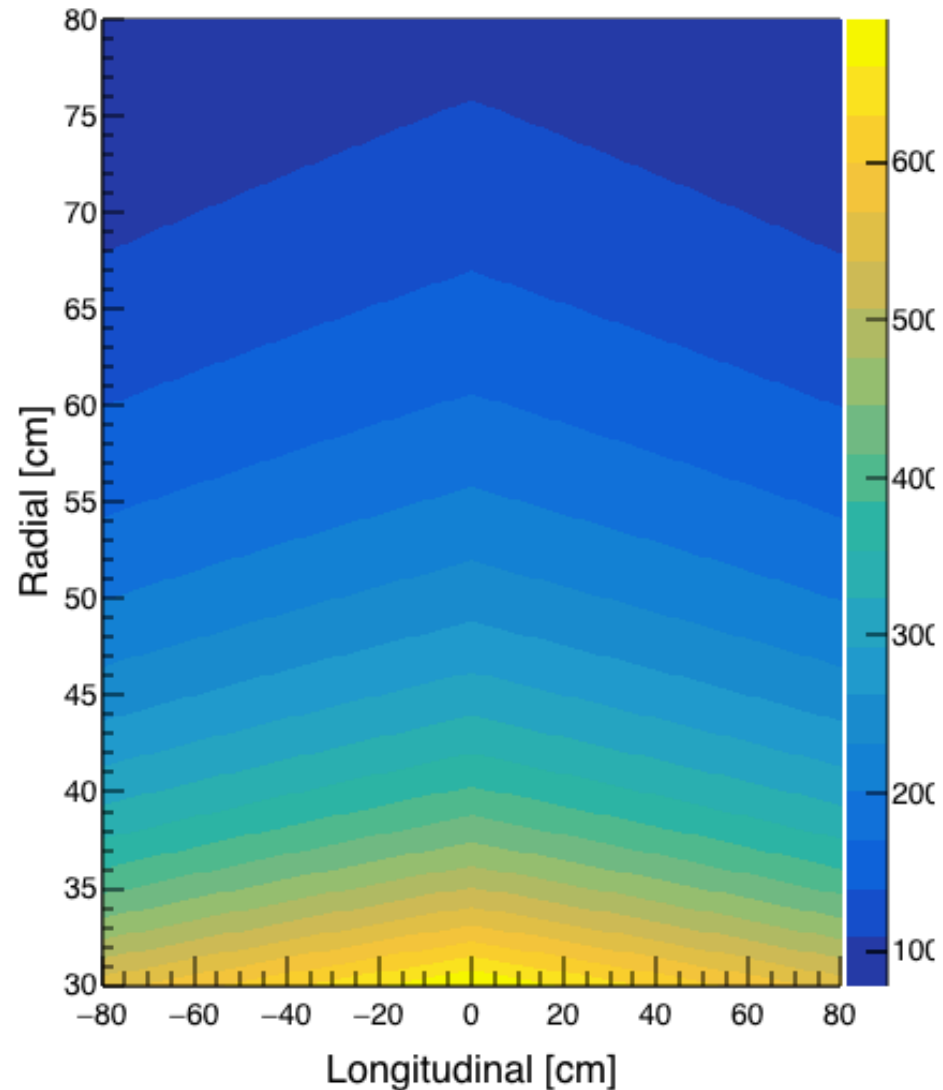
Back up

Based on Hijing simulation, $M = 1200$

ChargeDensity [fC/cm³]

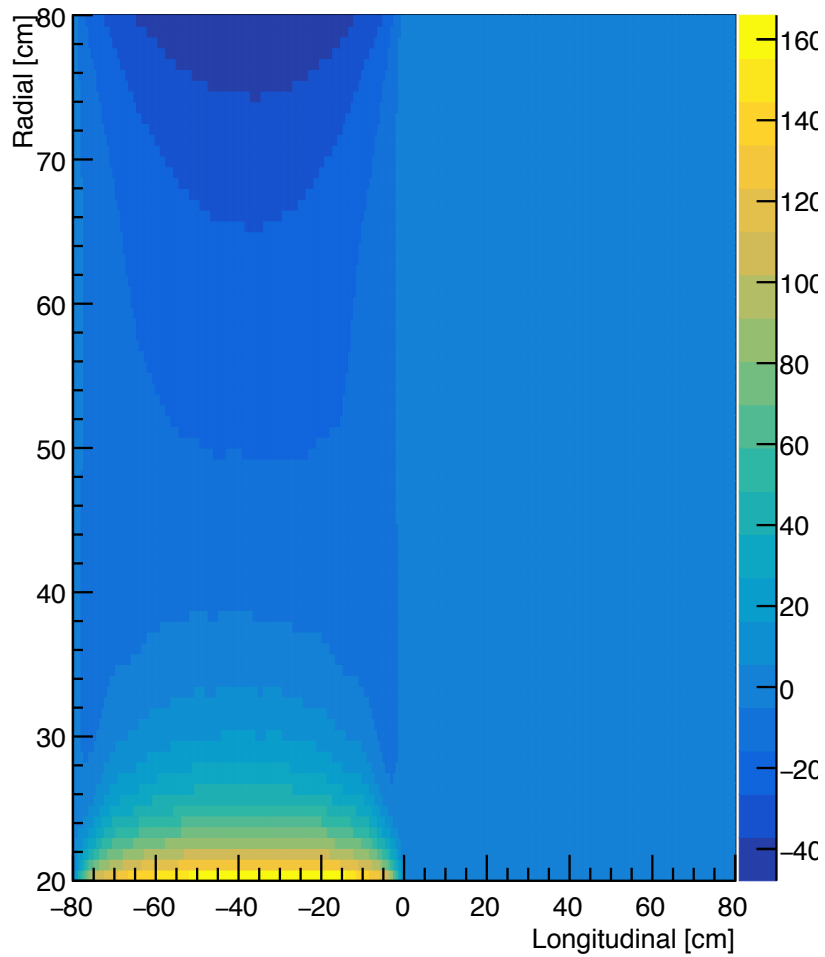


ChargeDensity [fC/cm³]

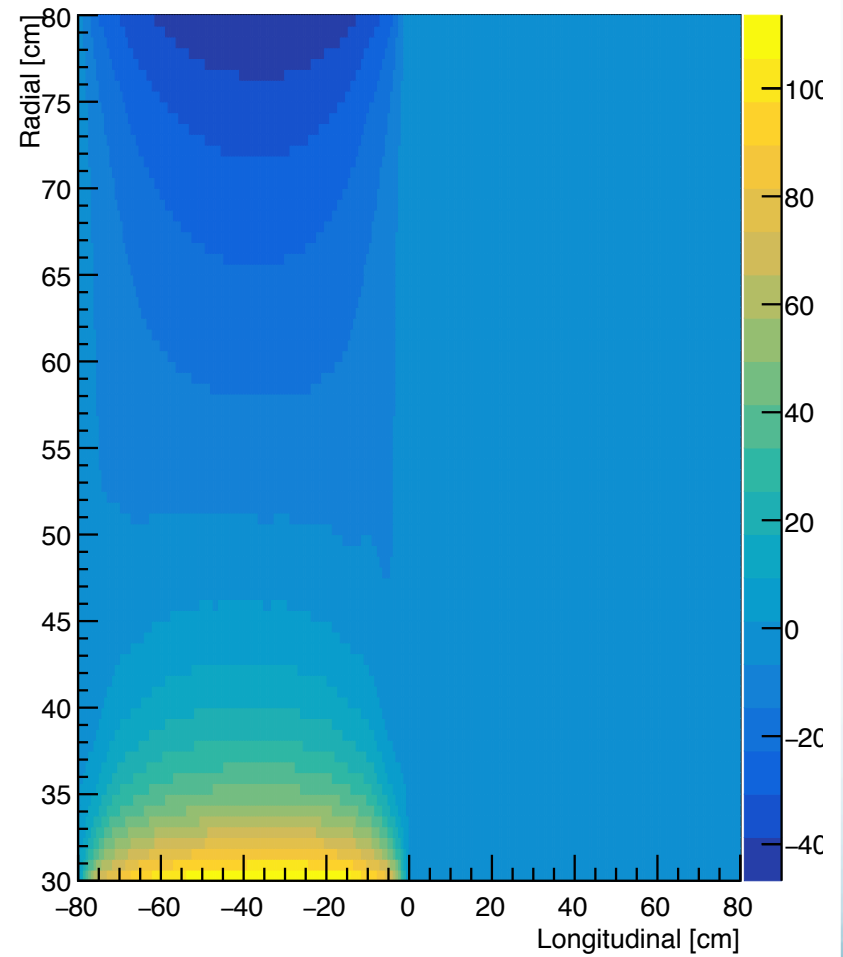


$$M = 1200$$

E_r [V/cm]

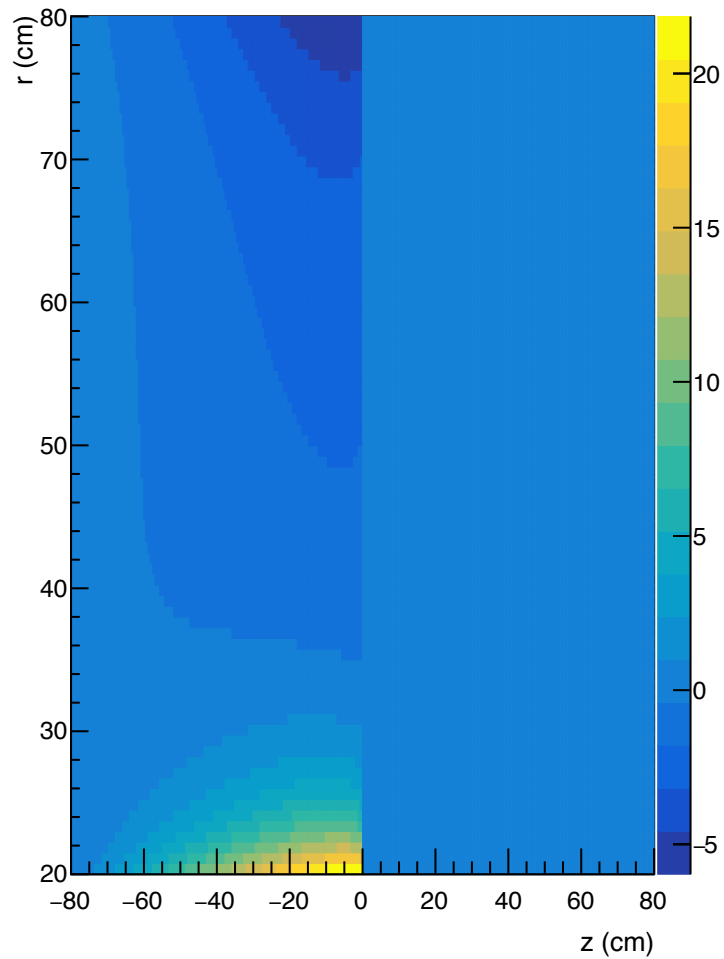


E_r [V/cm]

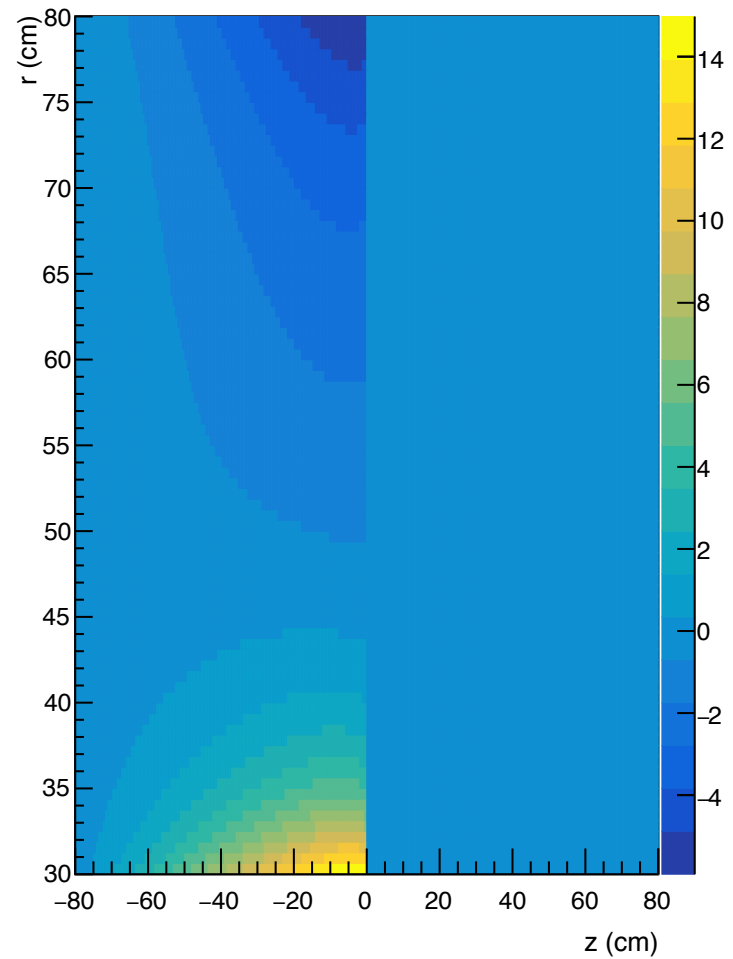


M= 1200

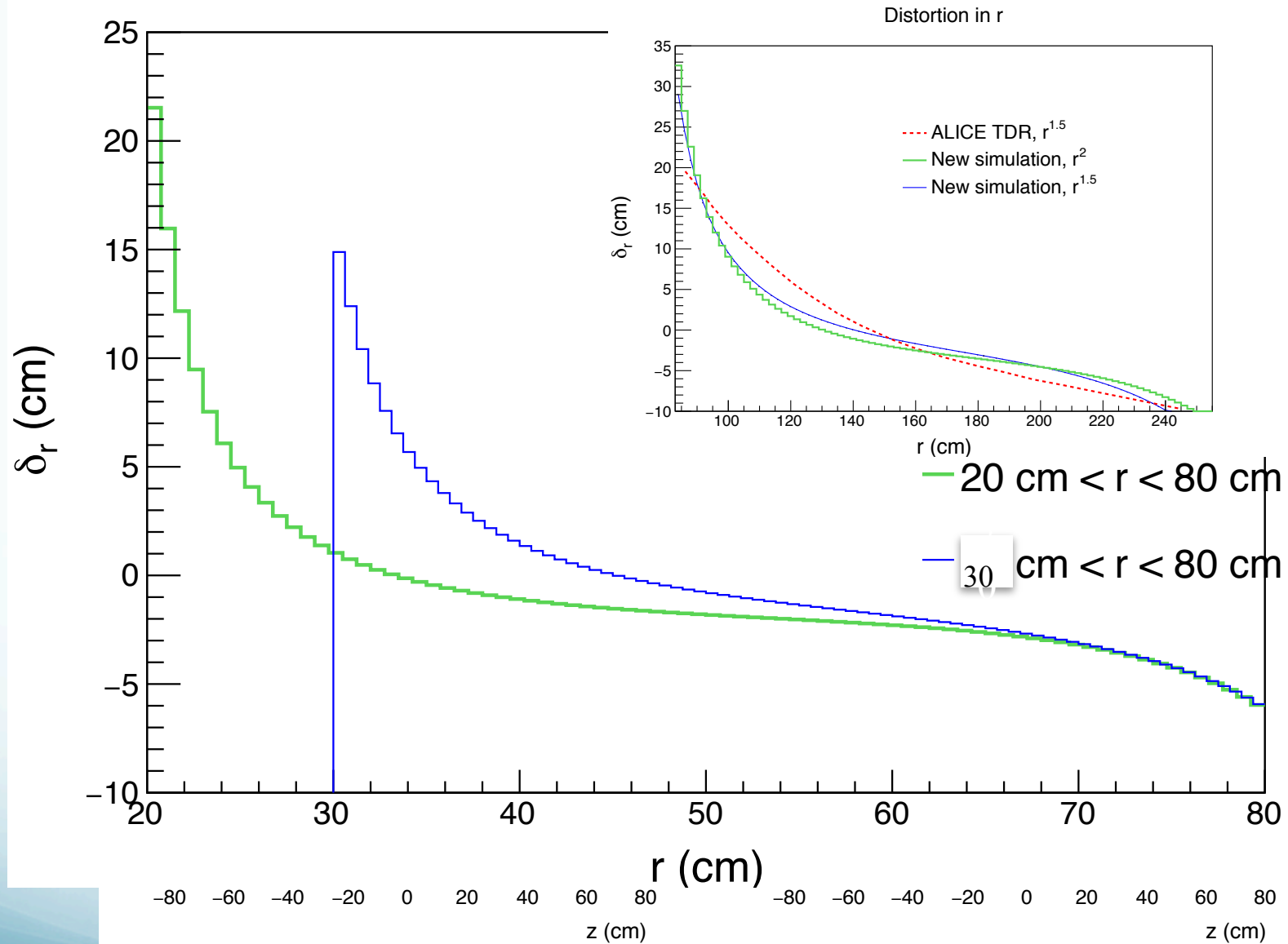
δ_R [cm] xz projection



δ_R [cm] xz projection



Distortion in r , Multiplicity = 1200, z= -0.5 cm



Distortion in sPHENIX even for high multiplicity events is smaller as compared to that in ALICE